

CLAIMS

What is claimed is:

1. A bone fixation apparatus comprising:
a bone fixation plate having a fixation hole; and
a modular bone fixation fastener received in the fixation hole, the bone fixation fastener including a shaft member and an expandable head member, the shaft member having an outer cam at a first end, the outer cam mating with a corresponding inner cam of the head member, such that upon rotation of the head member relative to the shaft member, the head member radially expands to prevent back out of the shaft member relative to the bone fixation plate.
2. The bone fixation apparatus of Claim 1, wherein the outer cam and the inner cam each have at least one lobe.
3. The bone fixation apparatus of Claim 1, wherein the outer cam and the inner cam each have a plurality of lobes.
4. The bone fixation apparatus of Claim 1, wherein the fixation hole includes a countersunk portion receiving at least a portion of the expandable head member of the bone fixation fastener.

5. The bone fixation apparatus of Claim 1, wherein each of the outer and inner cams includes three equidistant lobes.

6. The bone fixation apparatus of Claim 1, wherein the inner surface of the fixation hole is spherical and engages a spherical outer surface of the head member, such that the fixation fastener can be positioned at a plurality of angles relative to the plate before locking.

7. The bone fixation apparatus of Claim 1, wherein the bone fixation plate includes a viewing window.

8. The bone fixation apparatus of Claim 1, wherein the bone fixation plate is a spinal fixation plate for securing first and second vertebral bodies relative to one another.

9. The bone fixation apparatus of Claim 1, wherein the bone fixation plate is a spinal fixation plate for securing at least three vertebral bodies relative to one another.

10. The bone fixation apparatus of Claim 1, further comprising at least one viewing window.

11. The bone fixation apparatus of Claim 1, further comprising at least one aperture receiving an anchoring fastener.

12. The bone fixation apparatus of Claim 1, further comprising at least another fixation hole receiving another modular fixation fastener.

13. The bone fixation apparatus of Claim 1, in combination with an insertion and removal tool, the tool comprising a first driver attached to a handle, the driver adapted to engage the head member for rotation of the head member relative to the shaft member.

14. The bone fixation apparatus of Claim 13, wherein the tool comprises a second driver adapted to engage the shaft member for inserting and removing the shaft member to and from a bone portion when the fixation member is not locked.

15. The bone fixation apparatus of Claim 1, wherein the head member radially expands against an inner surface of the fixation hole to pressure-lock the fixation fastener and thereby prevent relative movement between the fixation fastener and the plate.

16. The bone fixation apparatus of Claim 1, wherein the head member and the fixation fastener are cooperatively configured to provide a first mode of operation in which the head member is prevented from backing out relative to the plate and the fixation fastener is adjustable relative to the plate and a second mode of operation in which the head member is prevented from backing out of relative to the plate and the fixation fastener is arrested relative to the plate.

17. A bone fixation apparatus comprising:

- a bone fixation plate having a fixation hole; and
- a modular bone fixation fastener received in the fixation hole, the bone fixation fastener comprising:
 - a shaft member having a head-receiving first end, the first end including a multi-radius outer surface defining a cam lobe; and
 - an expandable head having a multi-radius inner surface defining a cam lobe mating with the shaft cam lobe, such that upon rotation of the head member relative to the shaft member, the shaft cam lobe rotates out of alignment relative to the head cam lobe forcing the head member to expand radially to prevent back out of the shaft member relative to the bone fixation plate.

18. The bone fixation apparatus of claim 17, wherein the head member radially expands against an inner surface of the fixation hole to pressure-lock the fixation fastener and thereby prevent relative movement between the fixation fastener and the plate..

19. The bone fixation apparatus of claim 17, wherein the inner head surface and the outer shaft surface each define a plurality of mating cam lobes.

20. The bone fixation apparatus of claim 19, wherein the inner surface of the fixation hole is spherical and engages a spherical outer surface of the head member, such that the fixation fastener can be positioned at a plurality of angles relative to the fixation plate when the head member is not expanded.

21. The bone fixation apparatus of claim 17, wherein the head member and the fixation fastener are cooperatively configured to provide a first mode of operation in which the head member is prevented from backing out relative to the plate and the fixation fastener is adjustable relative to the plate and a second mode of operation in which the head member is prevented from backing out of relative to the plate and the fixation fastener is arrested relative to the plate.

22. A method for fastening bone portions to each other, the method comprising:

aligning a fixation plate for attachment to the bone portions;

aligning a first cam defined in a first portion of a modular fastener relative to a second mating cam defined in a second portion of the fastener;

inserting the modular fastener to one of the bone portions through a corresponding hole in the fixation plate; and

radially expanding a portion of the fastener relative to the hole, to prevent back out of the fastener.

23. The method of claim 22, further including selecting the orientation of the fastener relative to the fixation plate.

24. The method of claim 22, wherein expanding includes rotating the first cam out of alignment relative to the second cam.

25. The method of claim 22, further comprising pressure-locking the fastener to the fixation plate and thereby prevent relative movement between the fixation fastener and the plate.

26. The method of Claim 22, further comprising rotating a head member of the modular fastener relative to a shaft of the fastener to expand the head member.

27. The method of Claim 26, further comprising:
- rotating the head member to establish a first expanded diameter of the head member; and
 - rotating the head member to establish a second expanded diameter of the head member.

28. A method of surgically repairing bone with a fixation plate having a plurality of fixation holes, the method comprising:

cam-aligning an expandable head member of a modular fastener to a shaft member of the modular fastener;

inserting the fastener in one of the fixation holes; and

radially expanding the head member to prevent back out of the fastener from the fixation hole.

29. The method of Claim 28, wherein radially expanding comprises pressure locking the head member against the fixation hole and thereby prevent relative movement between the fixation fastener and the plate.

30. The method of Claim 28, wherein expanding further comprises rotating the head member out of cam alignment relative to the shaft member.

31. The method of Claim 30, wherein rotating includes engaging a portion of the head member with a driver and rotating the driver.

32. The method of Claim 28, further comprising unlocking the fixation fastener.

33. The method of Claim 32, wherein unlocking comprises unexpanding the head member.

34. The method of Claim 33, further comprising removing the fixation fastener.

35. The method of Claim 33, wherein unexpanding comprises rotating the head member into cam alignment with the shaft member.

36. The method of Claim 28, further comprising:
rotating the head member to establish a first expanded diameter of the head member; and
rotating the head member to establish a second expanded diameter of the head member.

37. A bone fixation apparatus comprising:

a bone fixation plate having a fixation hole, the fixation hole having a first diameter in a plane generally parallel to an upper surface of the bone fixation plate; and

a modular bone fixation fastener received in the fixation hole, the bone fixation fastener including a shaft member defining a shaft axis and an expandable head member carried by the shaft member, the expandable head member being rotatable about the shaft axis relative to the shaft member between a first position and a second position, such that in the first position the expandable head member has a maximum diameter that is smaller than the first diameter of the fixation hole, and in the second position the expandable head member has a maximum diameter that is greater than the first diameter.

38. The bone fixation apparatus of claim 37, wherein the expandable head member has a generally spherical outer surface.

39. The bone fixation apparatus of claim 38, wherein the fixation hole is generally spherical.

40. The bone fixation apparatus of claim 37, wherein the shaft member has a cam mating with a corresponding cam of the head member, such that in the first position the head and shaft cams are aligned and in the second position the head and shaft cams are misaligned.

41. The bone fixation apparatus of claim 37, wherein in the second position the fastener is pressure locked against the fixation hole and thereby prevent relative movement between the fixation fastener and the plate.